

## Research Highlight

Wrapped in pollution, dust diverts from its usual course and steers clear of water. Researchers at Pacific Northwest National Laboratory found the result closes one more gap in understanding how and when cloud ice crystals form. They found that dust, usually a primary catalyst encouraging ice formation, when modified by pollution from combustion, becomes less attractive for water vapor to initiate ice crystals under certain conditions. The “aged” dust particles, poor at catalyzing ice crystals, significantly alter the cloud environment by decreasing the number and concentration of ice crystals and ice water content.

“Currently, atmospheric models do not include calculations on the ice nucleation properties of aged aerosol particles,” said Dr. Gourihar Kulkarni, an atmospheric scientist at Pacific Northwest National Laboratory (PNNL) and lead author of the study. “We found that aged particles lack the optimal crystalline structure to act as ice nuclei.”

A research team led by PNNL scientists investigated the ice nucleating properties for different dust samples, from fresh- to aged-particles (those coated with acid), using the ice nucleation chamber located at PNNL’s Atmospheric Measurements Laboratory (AML). They integrated the laboratory ice nucleation measurements into the single-column version of the Community Atmosphere Model (S-CAM5) to understand the sensitivity in simulated cloud properties. They performed simulations to understand the influence of the coated dust particles on ice-containing clouds using observational data from the Atmospheric Radiation Measurement (ARM) Climate Research Facility’s Southern Great Plains site. In parallel, the team analyzed the diffraction patterns of test dust samples to understand how the crystalline properties of dust were important for ice nucleation. For this analysis, they used the X-ray diffractometer at the Environmental Molecular Sciences Laboratory.

More than half the Earth’s precipitation originates from ice in clouds. Scientists are working to understand all the ways an ice crystal is born, a process called ice nucleation. Representing this fundamental process in models will go a long way in reducing uncertainty in predicting climate change, specifically understanding aerosol-ice cloud interactions. The focus of the study was to understand the characteristics of dust particles that can attract water vapor and water droplets to form ice. Although its journey might last but a few days, dust plays a large role in what happens in clouds. Understanding what happens to the freshly emitted particles coated with human-caused pollution, such as acids, and how that changes a cloud’s structure, was a focus of this study. Researchers are working to fill gaps in understanding this fundamental process, ultimately to better understand climate change.

## Reference(s)

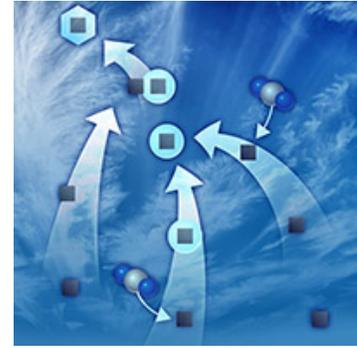
Kulkarni G, C Sanders, K Zhang, X Liu, and C Zhao. 2014. "Ice nucleation of bare and sulfuric acid-coated mineral dust particles and implication for cloud properties." *Journal of Geophysical Research – Atmospheres*, 119(16), doi:10.1002/2014JD021567.

## Contributors

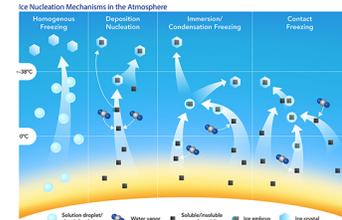
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## Working Group(s)

Aerosol Life Cycle



Cirrus clouds are composed of ice crystals often formed from supercooled water or water vapor freezing on dust particles. Researching this phenomena, scientists found when the crystalline structure of dust is disturbed by pollution, dust is less likely to act as an ice seed. The fate of dust and how it affects clouds is important for the climate.



Dust is a primary catalyst for ice formation in the atmosphere. This figure illustrates several ice nucleation mechanisms through which primary ice is formed, including those investigated in this research. Scientists found when dust particles are modified by pollution, they are poor at catalyzing ice crystals and significantly alter the environment of the cloud by decreasing the number and concentration of ice crystals and ice water content.